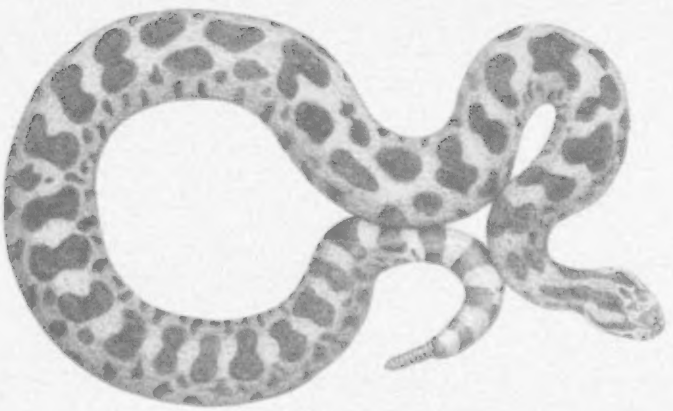
COSEWIC
Assessment and Update Status Report

on the

Massasauga
Sistrurus catenatus

in Canada



THREATENED
2002

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA

COSEPAC
COMITÉ SUR LA SITUATION DES
ESPÈCES EN PÉRIL
AU CANADA

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Please note: Persons wishing to cite data in the report should refer to the report (and cite the author(s)); persons wishing to cite the COSEWIC status will refer to the assessment (and cite COSEWIC). A production note will be provided if additional information on the status report history is required.

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Previous Report:

Weller, W.F. and H.J. Parsons. 1991. COSEWIC status report on the eastern massasauga *Sistrurus catenatus catenatus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 53 pp.

Production note:
Massasauga *Sistrurus catenatus* was formerly listed by COSEWIC as eastern *massasauga Sistrurus catenatus catenatus*. The currently recognized name of this species is *Sistrurus catenatus*, the massasauga (Crother et al. 2000). Massasaugas in Canada are of the subspecies *S. c. catenatus* (the eastern massasauga), which also occurs in several U.S. states. For the purposes of this COSEWIC report, the Canadian subspecies, the eastern massasauga, may be considered synonymous with *S. catenatus*, the Massasauga (Crother et al. 2000).

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COSEWIC
Assessment Summary

Assessment Summary – November 2002

Common name
Massasauga

Scientific name
Sistrurus catenatus

Status
Threatened

Reason for designation
The massasauga has undergone a large decline in distribution and abundance because of persecution by humans, mortality on the expanding road system in southern Ontario, loss of habitat via drainage of wetlands and destruction of hibernacula and fragmentation of habitat by roads. Recent efforts by the Recovery Team have reduced persecution by people, but expanding road systems, and cottage and urban development continue to reduce the range and abundance of this species.

Occurrence
Ontario

Status history
Designated Threatened in April 1991. Status re-examined and confirmed in November 2002. Last assessment based on an update status report.

COSEWIC
Executive Summary

Massasauga
Sistrurus catenatus

Species information

The Massasauga (*Sistrurus catenatus*), family Viperidae, is Ontario's only extant venomous snake. It is a relatively small-sized rattlesnake (average adult size ca. 76 cm total length) with a thick body and a segmented rattle on the tail tip. Background colour is gray to dark brown with dark brown dorsal blotches alternating with three rows of smaller lateral blotches. Ventral colour is dark brown or black, often with white mottling. Massasaugas may be confused with other non-venomous, banded/blotched Ontario species such as: Eastern Hog-nosed Snake (*Heterodon platirhinos*), Eastern Foxsnake (*Elaphe gloydi*), Eastern Milksnake (*Lampropeltis triangulum triangulum*) and Common Watersnake (*Nerodia sipedon sipedon*).

Distribution

The Massasauga is found in the northeastern United States in Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania and Wisconsin. In Canada, populations of this snake are restricted to four geographically distinct regions within Ontario. Historical evidence suggests that the Bruce Peninsula and western Georgian Bay populations in central Ontario were likely once a continuous population. The Wainfleet and Ojibway populations in southwestern Ontario are small and completely isolated. Again it is thought probable that they shared a continuous distribution with Massasaugas in the Bruce Peninsula and eastern Georgian Bay.

Habitat

The Massasauga's habitat varies from wet prairie, sedge meadows and old fields, to peatlands, bedrock barrens and coniferous forest; however, each habitat provides physical similarities to meet the species' habitat requirements. Massasaugas require a semi-open habitat to provide both cover from predators and opportunities for thermoregulation (i.e. basking). Hibernation sites are often damp or water-saturated, suggesting that moisture content is a key variable in successful hibernation. Both quantity and quality of Massasauga habitat in Ontario have declined, and in many places continue to decline, due to human encroachment.

Biology

The active season of the Massasauga is from late April to October in Canada. Mating occurs in late summer and females store the sperm until ovulation the following spring. Females mature between three and five years of age (males mature slightly earlier) and produce litters of 3-20 young every two to three years. Males and females begin returning to hibernacula in September, remaining in hibernation until April. Local climatic conditions (e.g. cooler than average temperatures) can affect the age of maturity, frequency of reproduction and active season of the Massasauga. Massasaugas primarily ambush terrestrial prey, but have also been observed actively hunting prey in both arboreal and aquatic habitats.

Population sizes and trends

The relative size of the four Massasauga populations is influenced by the quantity of habitat remaining at each site. The Georgian Bay population is the largest, followed by the Bruce Peninsula population. The southwestern Ontario populations exist at much lower densities and are likely several orders of magnitude smaller than the two central Ontario populations. Despite intensive searches in 2000, insufficient data are available to conduct population estimates in the southern Ontario populations; however, radio-tracking has shown that survivorship is low. These two populations appear to be at critically low levels.

Limiting factors and threats

Habitat destruction and fragmentation caused by human development are the most serious threats to the survival of the Massasauga in Ontario. In particular, the expansion of Hwy 69/400, along the shoreline of Georgian Bay, and the West Bruce Lands project, along the western shoreline of the Bruce Peninsula, will negatively affect the quality of Massasauga habitat within the projects' imr..ediate areas. Associated with these developments is an increase in the number of actively used roads, which increases the risk of snakes being killed while crossing or thermoregulating on roadways. The southwestern Ontario populations face the additional threat of stochastic extinction due to their small size and high degree of isolation.

Special significance of the species

As Ontario's only remaining venomous snake, the Massasauga provides a unique opportunity for humans to respect and co-exist peacefully with a creature that retains the ability to cause them harm. From a conservation perspective, it is important to note that the most secure populations of *S. c. catenatus* in North America occur in the Georgian Bay and Bruce Peninsula regions of Ontario.

Existing protection or other status designations

The Massasauga was designated Threatened by COSEWIC in 1991 and by the Ontario Ministry of Natural Resources in 1998. It is also considered a "specially protected reptile" under the 1999 Ontario Fish and Wildlife Conservation Act, making it illegal to harass, possess (without a permit), or kill individuals of this species. The species is ranked G3G4 globally.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) determines the national status of wild species, subspecies, varieties, and nationally significant populations that are considered to be at risk in Canada. Designations are made on all native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fish, lepidopterans, molluscs, vascular plants, lichens, and mosses.

COSEWIC MEMBERSHIP

COSEWIC comprises representatives from each provincial and territorial government wildlife agency, four federal agencies (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biosystematic Partnership), three nonjurisdictional members and the co-chairs of the species specialist groups. The committee meets to consider status reports on candidate species.

DEFINITIONS

Species	Any indigenous species, subspecies, variety, or geographically defined population of wild fauna and flora.
Extinct (X)	A species that no longer exists.
Extirpated (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A species facing imminent extirpation or extinction.
Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Not at Risk (NAR)**	A species that has been evaluated and found to be not at risk.
Data Deficient (DD)***	A species for which there is insufficient scientific information to support status designation.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.
** Formerly described as "Not In Any Category", or "No Designation Required."
*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list.

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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

Update
COSEWIC Status Report

on the

Massasauga
Sistrurus catenatus

in Canada

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2002

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Parry Sound, ON
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SPECIES INFORMATION

Name and Classification

Class:	Reptilia
Order:	Squamata
Suborder:	Serpentes
Family:	Viperidae
Subfamily:	Crotalinae
Species:	*Sistrurus catenatus* (Rafinesque 1818) Massasauga
Subspecies:	*S. c. catenatus* Eastern Massasauga
Number of subspecies:	3
Number of subspecies in Canada:	1

Description

The Eastern Massasauga (hereafter, Massasauga) is Ontario's only extant venomous snake. It is a thick-bodied, dorsally blotched snake with a small well-developed rattle at the end of its tail. The Massasauga has elliptical pupils and a pair of heat-sensitive facial pits situated between the eyes and nostrils. *Sistrurus catenatus catenatus* is a relatively small rattlesnake with adults averaging approximately 76 cm in total length (Conant and Collins 1998). Lateral and dorsal scales often have a gray to dark brown background colouration with dark brown dorsal blotches alternating with three rows of smaller lateral blotches. The ventral scales are dark brown or black, often with white mottling (J. Rouse personal observation). Neonates and yearlings look similar to the adults, except that they have a grayer background colour resulting in a higher contrast between background and blotches, and the rattle is not as developed. In Ontario, Massasaugas may be confused with several banded/blotched snake species including the Eastern Hog-nosed Snake (*Heterodon platirhinos*), Eastern Foxsnake (*Elaphe gloydi*), Eastern Milksnake (*Lampropeltis triangulum triangulum*) and Common Watersnake (*Nerodia sipedon sipedon*).

DISTRIBUTION

Global Range

Historically, the Eastern Massasauga ranged from Minnesota and Iowa in the west, to Ohio in the east, and to central Ontario in the north. *Sistrurus catenatus catenatus* occurs in the states of Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, and Wisconsin, and the province of Ontario (Figure 1; Johnson *et al.* 2000). However, evidence suggests that the subspecies has recently been extirpated from Minnesota (Szymanski 1998).

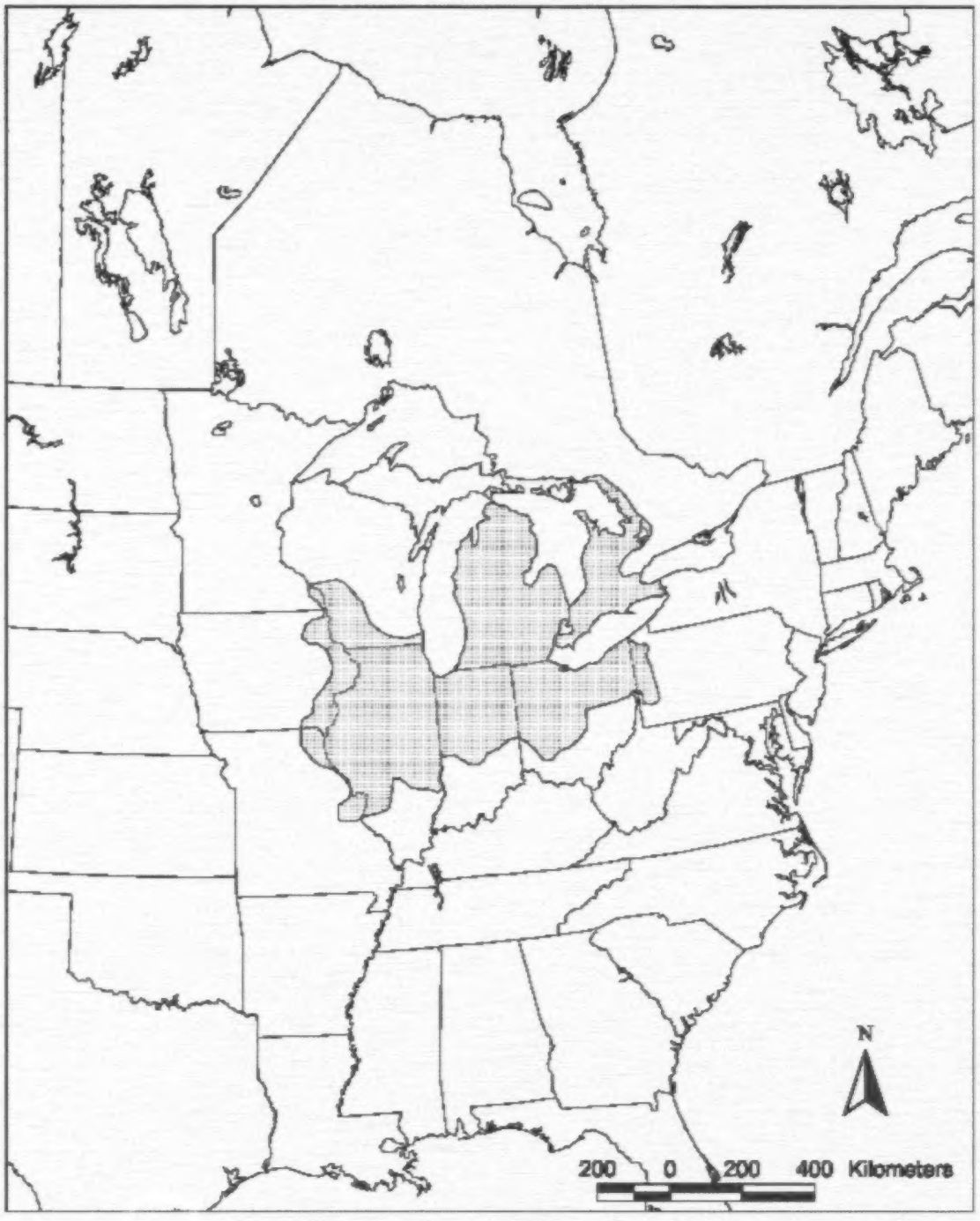

Figure 1. North American distribution for the Eastern Massasauga.

Canadian Range

Sistrurus catenatus is currently found in Canada in four geographically disjunct localities of unequal size and extent, all in Ontario (Prior *et al.* 2000). The largest of the four populations, at least in terms of contiguous suitable habitat, occurs along the eastern shores of Georgian Bay from near Port Severn north to Killarney (ca. 5 484 km^2; mixedwood shield ecoregion; Prior *et al.* 2000; Figure 2). Although relatively undisturbed habitat exists from Georgian Bay to Algonquin, Massasaugas are restricted to a band of habitat that follows the shoreline (maximum recorded distance inland is ca. 50 km; Prior *et al.* 2000). The second largest Massasauga population in Ontario occurs on the Bruce Peninsula from Oliphant to Fitzwilliam Island, just south of Manitoulin Island (ca. 1 963 km^2; mixedwood plains ecoregion; Prior *et al.* 2000). Although historical evidence suggests that these two regional populations were once continuous (Weller and Parsons 1991), it is highly probable that these populations are now completely disjunct. The two Massasauga populations occurring in southern Ontario (deciduous forest zone) are comparatively small and isolated. The Wainfleet population is centred in a 1500-ha peatland located along the Niagara peninsula near Port Colborne (Figure 3), and the Ojibway population encompasses several prairie and old field fragments (suitable habitat restricted to ca. 450 ha) within the town of LaSalle and just inside the city limits of Windsor (Figure 4).

HABITAT

Habitat requirements

Like other reptiles living in northern latitudes, Massasaugas are restricted to climatic regions where daily and seasonal temperatures permit them to successfully carry out fundamental life processes (e.g., feeding, reproduction). In particular, suitable temperature regimes are critical for successful reproduction and hibernation at these northern latitudes. To achieve these temperatures, Massasaugas require a semi-open habitat that provides sufficient cover from predation and the elements, while providing thermoregulatory opportunities necessary for activities such as gestation and digestion. Studies in Ontario, as well as from the rest of the Eastern Massasauga's distribution in the U.S.A., strongly suggest moisture content of the substrate to be a key variable in successful hibernation (see Johnson *et al.* 2000 for review). Massasaugas frequently overwinter in damp or water-saturated sites, often characterized by the presence of sphagnum moss, although water-saturated old fields with crayfish and rodent burrows are also commonly used where present. Physical data collected over the winter of 2000 at six known Massasauga hibernacula in Georgian Bay showed that water levels were close to the surface at all sites (J. Rouse *et al.* unpublished data).

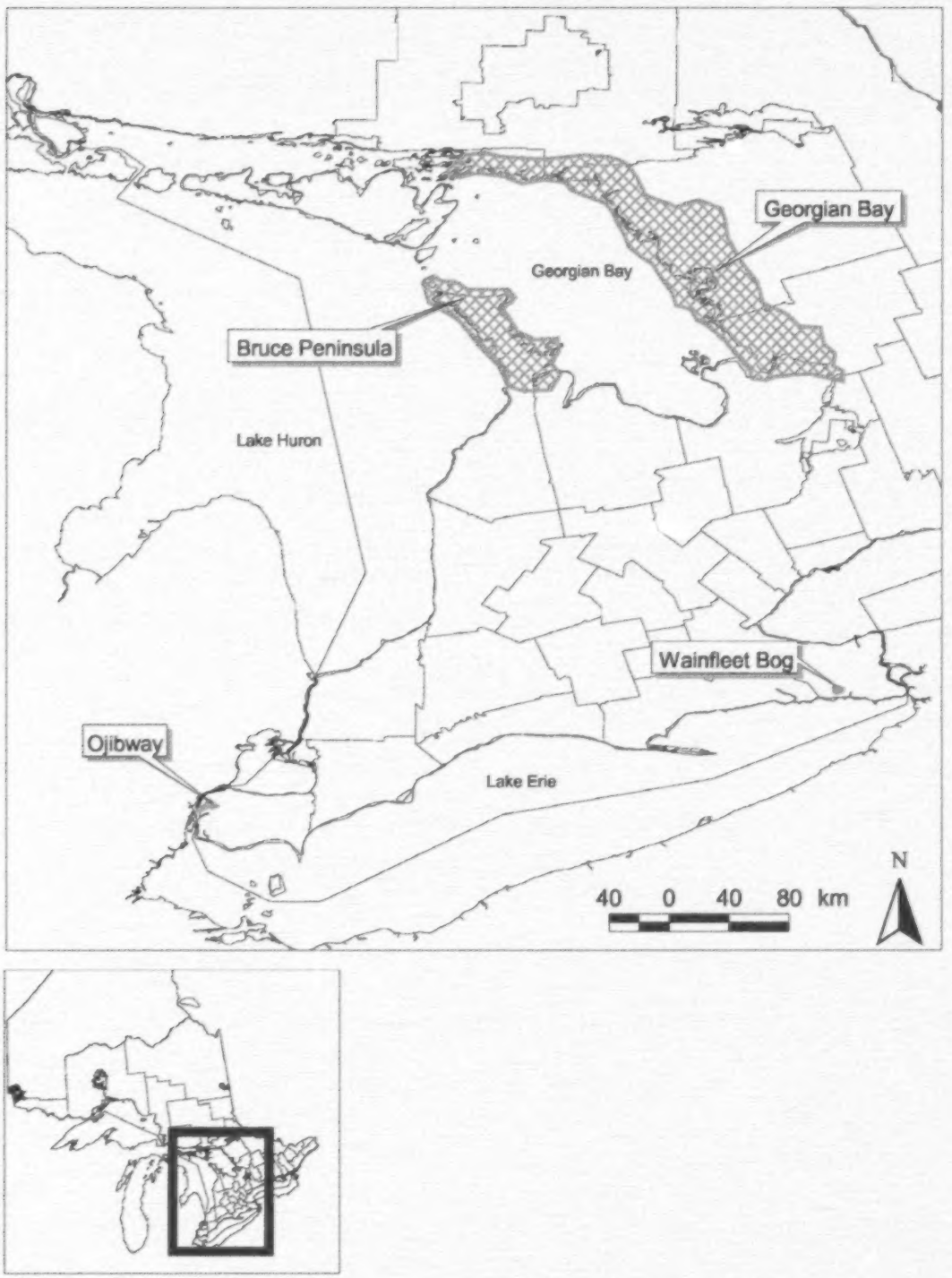

Figure 2. Current Ontario distribution for the Eastern Massasauga.

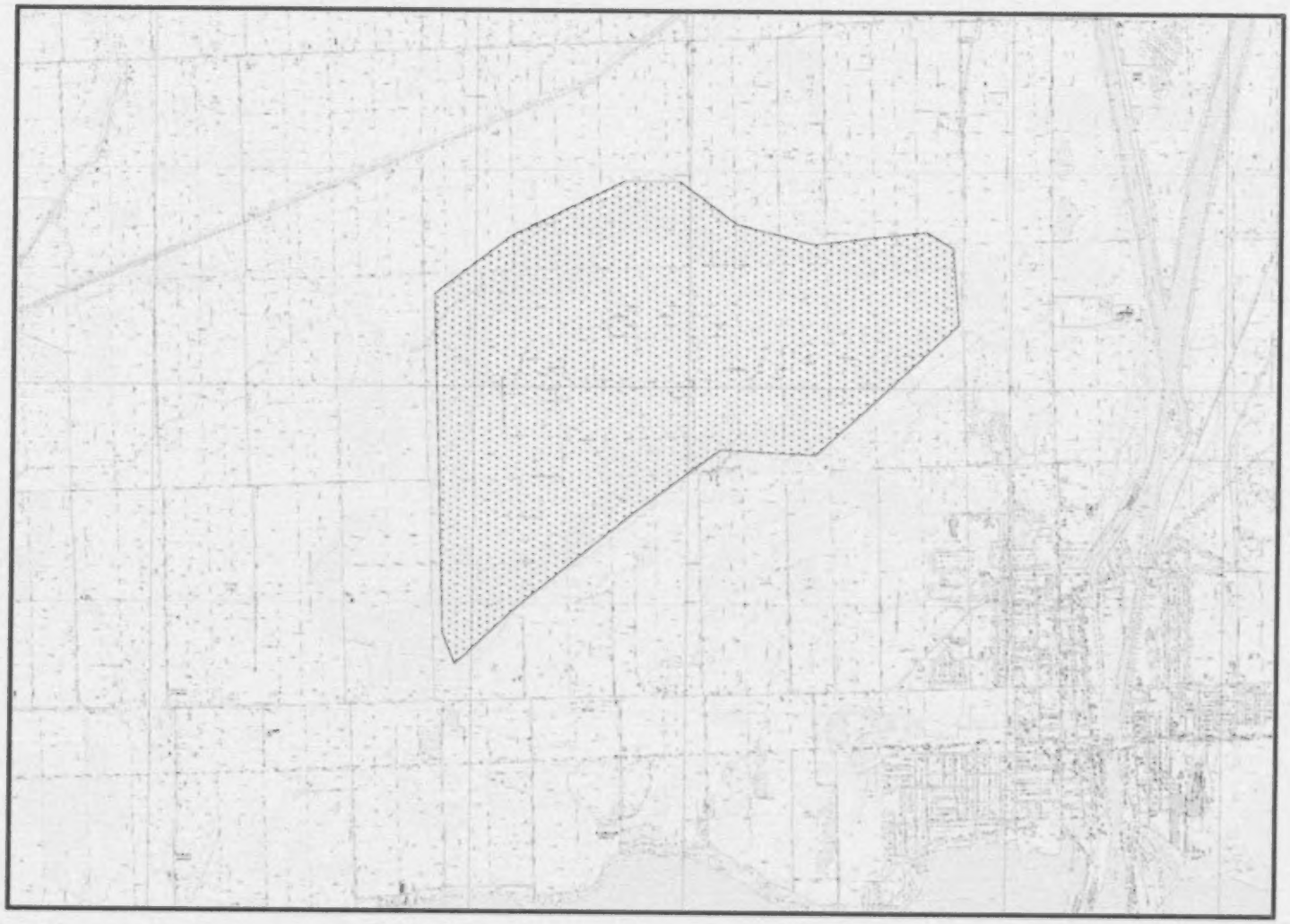

Figure 3. Wainfleet Bog, hatch pattern represents the approximate area of potential Massasauga habitat.

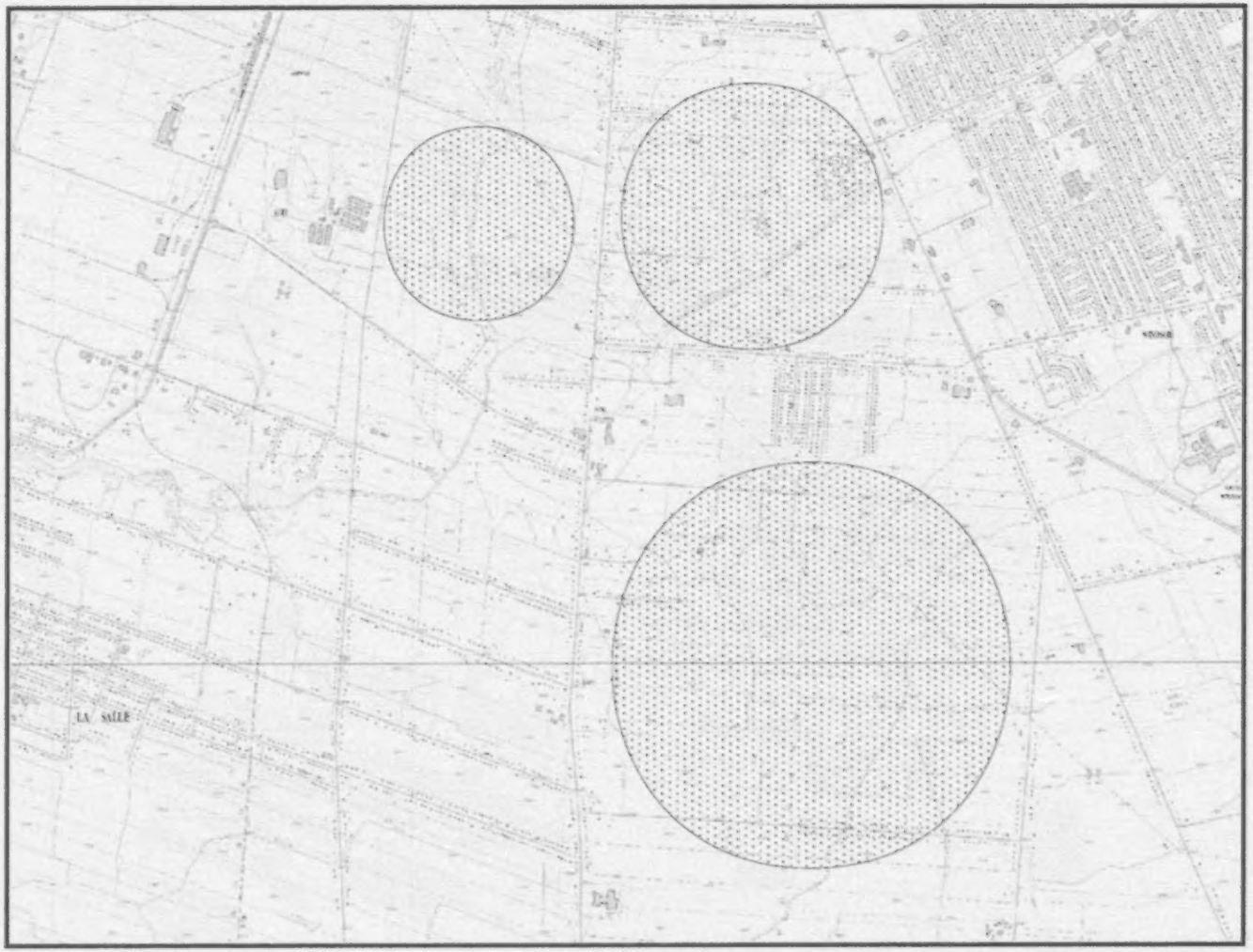

Figure 4. Windsor / LaSalle, hatch pattern represents the approximate area of potential Massasauga habitat.

Massasaugas utilize strikingly different habitats across their range (Prior *et al.* 2000). For example, they are known to use wet prairie (Seigel 1986), fens and sedge meadows (Johnson 1995, Kingsbury 1996, 1999), peatlands (Johnson 1995, Johnson and Leopold 1998), bedrock barrens (Parent 1997, J. Rouse personal observation), coniferous forest (Weatherhead and Prior 1992), meadows and old fields (Reinert and Kodrich 1982). Although these habitats vary considerably in terms of floral composition and structure, all possess distinctive microhabitats exhibiting physical similarities. For example, granite table rocks situated in rock barrens in Georgian Bay may offer similar daily temperatures to gestating females as would mounds of rotting vegetation or brush piles found in old fields or prairie (R. Willson personal observation). Extensive radiotelemetric data have shown Georgian Bay Massasaugas to use a mosaic of bedrock barrens, conifer swamps, beaver meadows, fens, bogs, and shoreline habitats (M. Villeneuve unpublished data, Beausoleil Island; C. Parent unpublished data, Killbear Provincial Park; Rouse *et al.* 2001, Hwy 69 corridor). More limited radiotracking of Massasaugas on the Bruce Peninsula has shown them to use shore marshes, shrubby swamps, fens, and small clearings associated with coniferous forest (Weatherhead and Prior 1992). Finally, recent radiotelemetry data collected from Massasaugas occurring in the southern Ontario populations have shown them to use tall grass prairies composed of dry, sandy, low forb prairie, and recently disturbed goldenrod dominated habitats at Ojibway and bog habitat, wet woods, adjacent farm fields, old fields, and hedgerows at Wainfleet (Pratt *et al.* 2000).

Trends

The quantity and quality of habitat remaining at all four sites has continued to decline since 1991, albeit at different rates and scale. Thus, it is likely that the Georgian Bay and Bruce Peninsula populations have lost more habitat to human development, in terms of area, but that the southern Ontario populations have experienced more serious habitat loss, in terms of percentage of habitat remaining. For example, the loss of a 20-ha old field for the Ojibway population is far more serious than an equivalent loss of area in either Georgian Bay or the Bruce. Increases in housing and cottage developments, associated road infrastructure, and human use of these areas threatens the continued existence of all formally unprotected habitat within the four Massasauga populations. Particularly alarming is the fact that the Ojibway population, LaSalle/Windsor area, has lost more habitat in the last five years than in the previous 20 years (P. Pratt personal communication). In contrast, ca. 74% of Wainfleet Bog/Marsh is under public ownership and peat mining has ceased in these areas. Active peat mining, however, still occurs adjacent to those areas now protected (R. Tervo personal communication).

Protection/ownership

Within the extent of the Georgian Bay and Bruce Peninsula populations, habitat currently used by Massasaugas is protected within the boundaries of two national parks, Georgian Bay Islands and Bruce Peninsula, and several provincial parks. Additional Massasauga habitat will be afforded protection as a result of regulations under the new

"Conservation Reserves and Park Additions" as part of Ontario's Living Legacy (OLL) Program. Important habitat on crown land is also given reasonable levels of protection. The Wainfleet Bog (1500 ha) is designated a Class 1 wetland and the majority of the bog is publicly owned and protected (Niagara Peninsula Conservation Authority – 801 ha; OMNR - 231 ha; Nature Conservancy of Canada - 81 ha, Pratt *et al.* 2000). Although several parcels of potential Massasauga habitat, mainly tallgrass prairie, have formal protection within the boundaries of the City of Windsor and adjacent town of LaSalle (total ca. 250 ha), only one LaSalle site has had recent rattlesnake sightings. No reliable observations of the species have been made in the protected Windsor sites since the mid-1970s. Most recent observations (captures or radiotelemetric relocations) have been from unprotected locations that are in developing residential areas of LaSalle and Windsor. Re-colonization of the protected sites from nearby unprotected areas currently harbouring Massasaugas is becoming more unlikely as roads continue to innervate all available corridors between the remaining habitat patches. Plans are underway to protect the remaining 117 ha of potential Massasauga habitat within the City of Windsor if funding can be secured. Unlike current (or potential) Massasauga habitat in Georgian Bay and the Bruce Peninsula, habitat in southwestern Ontario not expressly purchased for protection has little chance of remaining in a natural state. The lack of any extensive areas of crown land in southwestern Ontario necessarily constrains Massasaugas to small habitat fragments that have, in many cases, long been isolated.

BIOLOGY

Activity Range and Movements

Massasaugas are active from roughly late April to October across their Canadian range. Limited information has been published on the activity range and movements of Massasaugas in Ontario (e.g., Weatherhead and Prior 1992). Unpublished information from Ontario indicates that Massasauga movement patterns can vary substantially between populations or study sites (C. Parent, J. Rouse, P. Pratt, R. Tervo unpublished data). In a peninsular population in Killbear Provincial Park (hereafter Killbear), males and nongravid females may move up to 500 m by 1000 m in any one active season (activity range, C. Parent unpublished data); whereas, males and non-gravid females within a study population further inland from Georgian Bay (but still only 40 km south of Killbear) have activity ranges up to 1000 m by 2000 m, with one male moving over 4000 m from initial capture location to his overwintering site (Rouse *et al.* 2001). While gravid (see Reproduction), Massasaugas are relatively sedentary and can often be relocated at their preferred gestation site until parturition. Massasaugas often shift their centres of activity between seasons: spending the fall, winter and spring in wet, heavily-vegetated habitats (at least in comparison to the surrounding habitat matrix), such as conifer swamps; then moving to upland, drier habitats in the summer (e.g., bedrock barrens; Reinert and Kodrich 1982, Seigel 1986, Weatherhead and Prior 1992, Johnson 2000, Pratt *et al.* 2000, Parent and Weatherhead 2000, Rouse *et al.* 2001).

Reproduction

The Massasauga is ovoviviparous (considered synonymous with viviparous by some) and most commonly reproduces biennially in Ontario; however, triennial or greater cycles also occur (Parent *et al.* unpublished data) because of the short activity season available for females to acquire sufficient energy reserves to invest in reproduction. In Ontario, climatic conditions and local site characteristics (e.g., prey density) can influence age of maturation. Although there is substantial variation among individuals in age of maturity, even within single populations (C. Parent *et al.* unpublished data), females generally mature between five and six years of age and it is presumed that males mature slightly earlier. Throughout Ontario, mating occurs in late summer (late July to early September) and females store the sperm until ovulation the following spring. In Killbear, gravid Massasaugas on average spend two to three weeks in foraging habitat before making predictable movements to distinctive microhabitats (gestation sites or rookeries), where they will remain until parturition in late summer (mid-July to mid-September; J. Rouse and R. Willson unpublished data). In some areas, optimal gestation sites may be of limited occurrence and their rarity may contribute to their use by multiple females (although thermoregulatory and social roles for communal rookeries are also likely; R. Willson unpublished data). Litter sizes range from 3 to 20 young (mean = 13± 2.74; SD; Parent and Weatherhead 2000) and neonates average 20 cm SVL.

Hibernation

Although Massasaugas are most commonly reported to be solitary hibernators; data from Killbear and the Hwy 69 corridor show that occupancy of a definable hibernaculum (i.e., a site with obvious boundaries such as a low-lying mossy depression within a rock outcropping or bedrock barren) can vary, and may range from one individual to ten or more individuals (C. Parent unpublished data, Rouse *et al.* 2001). In Ontario, Massasaugas begin to make recognizable movements (i.e., often relatively straight-line movements, J. Rouse, R. Willson personal observations) back to the vicinity of their hibernacula in September and are often underground by the end of September or middle of October (C. Parent unpublished data, Rouse *et al.* 2001). Neonate Massasaugas, not having hibernated before, may scent-track conspecifics to hibernacula. Fortuitous mark-recapture data has demonstrated that neonate Massasaugas are capable of moving at least 400 m from their birth site to find a suitable hibernaculum, in this case, a previously documented den site (J. Rouse *et al.* unpublished data). Fissures in the bedrock, cavities associated with tree roots, animal burrows, including those of crayfish, have all been documented as Massasauga hibernacula in Ontario.

Food and Feeding

Massasaugas are primarily diurnal, sit-and-wait (ambush) predators, but can be nocturnally active during the warmer months (July and August) and will also actively forage. Although their morphology dictates mainly terrestrial foraging, Massasaugas

have been observed actively searching for, and consuming, prey in arboreal habitats. Small mammals and songbirds are their primary prey items in Ontario (K. Prior unpublished data, C. Parent *et al.* unpublished data). Young Massasaugas will feed on the young of smaller snake species (Seigel 1986, J. Rouse, R. Willson personal observations) and also may consume amphibians and invertebrates (Seigel 1986).

Survival

Probable natural predators of adult Massasaugas in Ontario include the larger birds of prey, such as great horned owls (*Bubo virginianus*) and red tailed hawks (*Buteo jamaicensis*) and carnivorous mammals such as fisher (*Martes pennanti*), raccoons (*Procyon lotor*), red fox (*Vulpes vulpes*), and coyote (*Canis latrans*). The young are vulnerable to a wider variety of avian and mammalian predators. Harsh winters (e.g., colder temperatures and/or less snow cover than usual, etc.) leading to unsuccessful overwintering are a major source of natural mortality in adults, and probably to a higher degree in neonates (C. Parent personal communication).

Behaviour/adaptability

At least in the short term, Massasauga populations can be resilient to the negative effects of intermediate to high levels of human disturbance—a fact attested to by the mere existence of the Ojibway population. Massasaugas can co-exist with relatively high levels of human use over short periods, as evidenced by the continued use of shelter rocks (frequently gestation sites) immediately adjacent to well-used human trails in Killbear (Parent and Weatherhead 2000). Additionally, gravid Massasaugas successfully brood their young at these sites, and return in subsequent years of reproductive activity (i.e., in two- to three-year intervals; C. Parent unpublished data; J. Rouse and R. Willson personal observations). Data from Killbear also suggest that Massasaugas seem able to incorporate disturbed areas (e.g., regularly used campgrounds) into their yearly activity ranges (Parent and Weatherhead 2000). Therefore, it is probable that Massasauga populations can persist as long as suitable habitat remains and human-induced mortality (e.g., direct persecution and roadkill) is limited.

Genetics

Gibbs *et al.* (1997) used six microsatellite DNA loci to elucidate information on the degree of genetic differentiation of five regional populations of Eastern Massasauga from Bruce Peninsula National Park, Killbear Provincial Park-Eastern Georgian Bay, Beausoleil Island-Eastern Georgian Bay, Cicero Swamp Wildlife Management Area-New York, and areas around Springfield-West-Central-Ohio. The results demonstrated that all five geographically separated populations were genetically distinct, and based on these data Gibbs *et al.* (1997) concluded that geographically disjunct populations of Eastern Massasaugas likely harbour a unique and substantial portion of the total genetic variation within this subspecies. In addition, Lougheed *et al.* (2000) found similar levels of genetic differentiation among geographically isolated Massasauga

populations using randomly amplified polymorphic DNA (RAPD) markers. These data suggest that Massasauga populations long isolated by distance and time (e.g., Wainfleet and Ojibway) will be relatively distinct in terms of their genetic composition.

POPULATION SIZES AND TRENDS

Since the last report on the Massasauga's status in Canada (Weller and Parsons 1991), substantially more demographic data have been collected; unfortunately, few of the data have been published in peer-reviewed literature, nor have the data been made available from the primary research collecting the information. The relative size of the four Massasauga populations in Ontario roughly parallels the quantity of habitat existing at each site. Thus, the Georgian Bay population would likely contain the greatest number of Massasaugas, followed by the Bruce Peninsula population. The sizes of the southern Ontario populations are several orders of magnitude smaller than the two regional populations. It is difficult to say, however, which population, Wainfleet or Ojibway, is in a more precarious state in terms of numbers of animals. Both southern Ontario sites exhibit significantly lower capture rates per unit of search effort compared to similarly-sized areas within the regional populations.

At the Wainfleet site, a total of 1,060 person hours were spent searching for Massasaugas in 2000 (Pratt *et al.* 2000). These searches yielded nine Massasaugas (four females, one male, four neonates). Two of these females were gravid in 2000 and successfully gave birth. Of the three Massasaugas radiotracked at Wainfleet in 2000, an unknown predator killed one, one developed what would have been a fatal abdominal infection (unrelated to the transmitter implantation), and the third successfully overwintered (Pratt *et al.* 2000).

At the Ojibway site, a total of 156 hours were spent in the field searching for Massasaugas from 1999 to 2000. During this time, a total of 26 Massasaugas were located (four gravid females, two nongravid females, two males, and 18 neonates; Pratt *et al.* 2000). Five individuals (four females and one male) were subsequently radiotracked. Unfortunately, all of the females died within one year of their implantation date: two females were depredated by unknown predators shortly after implantation, one was killed by a motor vehicle on a newly constructed road after ca. 11 months of radiotracking, and finally, one died overwintering in a small animal/crayfish burrow. The lone male survivor has successfully overwintered, and has been observed mating in two consecutive years (Pratt *et al.* 2000).

Examination of the data collected from the southern Ontario populations should make it clear that conventional population estimation techniques are not appropriate at this stage; it should be enough to say that the population levels are critically low. Additionally, if the modeling of other vertebrate populations is at all reliable, then the Massasauga populations at both Wainfleet and Ojibway cannot be viable in the long term (e.g., see Seigel and Sheil 1999, but see caveats therein).

Whereas the estimation of population parameters at Wainfleet and Ojibway is plagued by low sample sizes; the expansiveness of the regional populations of Georgian Bay and the Bruce Peninsula make an estimation of total population size extremely difficult and likely unreliable. Additionally, there are many areas in Georgian Bay where field surveys for snakes have been inadequate, and attempts to model, and thus predict, areas of Massasauga occurrence based on physical parameters have largely been unsuccessful. On a local level, however, there has been intensive, relatively long term collection of demographic data for the Killbear Massasauga population (Parent *et al.* unpublished data). At this site, a rigorous mark-recapture program has continued since 1994 and was first initiated in 1992. Consequently, estimation of population parameters for the Killbear population is feasible and currently underway (C. Parent personal communication); however, these data are not available at this time. For comparison with the southern Ontario populations, ca. 80 adult and juvenile Massasaugas, and between 50 and 300 neonates are captured and "processed" each season; the majority of them being captured within two study sites, each ca. 150 ha in size. Recent, intensive mark-recapture studies north of Moon River and west of Mactier (the new Hwy 69 corridor) have found similar numbers of Massasaugas: 100 adults and juveniles and ca. 100 neonates (2000 and 2001; J. Rouse *et al.* unpublished data). While this study site is larger, at approximately 650 ha, it does provide additional evidence that the southern Ontario populations exist at low densities. Estimation of population parameters for this Hwy 69 corridor site should be feasible upon the conclusion of the third sampling period in 2002. Mark-recapture studies on Bruce Peninsula populations have been conducted, albeit at lower intensities and duration (e.g., Prior 1996, cited in Parker and Prior 1999). In 2000, Bruce Peninsula National Park (BPNP) initiated a long-term monitoring program for Massasaugas (F. Burrows personal communication). Finally, a recent radiotelemetric investigation of the thermal ecology of Massasaugas in BPNP was initiated in 2001, and researchers located ca. 50 Massasaugas over the field season (F. Burrows personal communication; Weatherhead *et al.* unpublished data).

LIMITING FACTORS AND THREATS

Since the Massasauga was designated *threatened* by COSEWIC in 1991, several of the factors contributing to the species decline (Figure 6) in Canada have continued unabated. Foremost in severity, habitat destruction and fragmentation has accelerated in recent years. Tightly coupled to the continuing fragmentation of remaining habitat is a concomitant increase in the number of actively used roadways (Figure 5). Consequently, incidental mortality of Massasaugas on roadways has become a serious concern to their conservation. Perhaps the only limiting factor that has decreased in impact since 1991 is direct human persecution, although it no doubt still occurs across the Massasauga's range. This anecdotally documented decrease in human persecution is largely a result of the tireless education efforts of concerned groups at the Metro Toronto Zoo, as well as other dedicated individuals and organizations.

Figure 5. Current distribution for the Eastern Massasauga and main roads in Ontario.

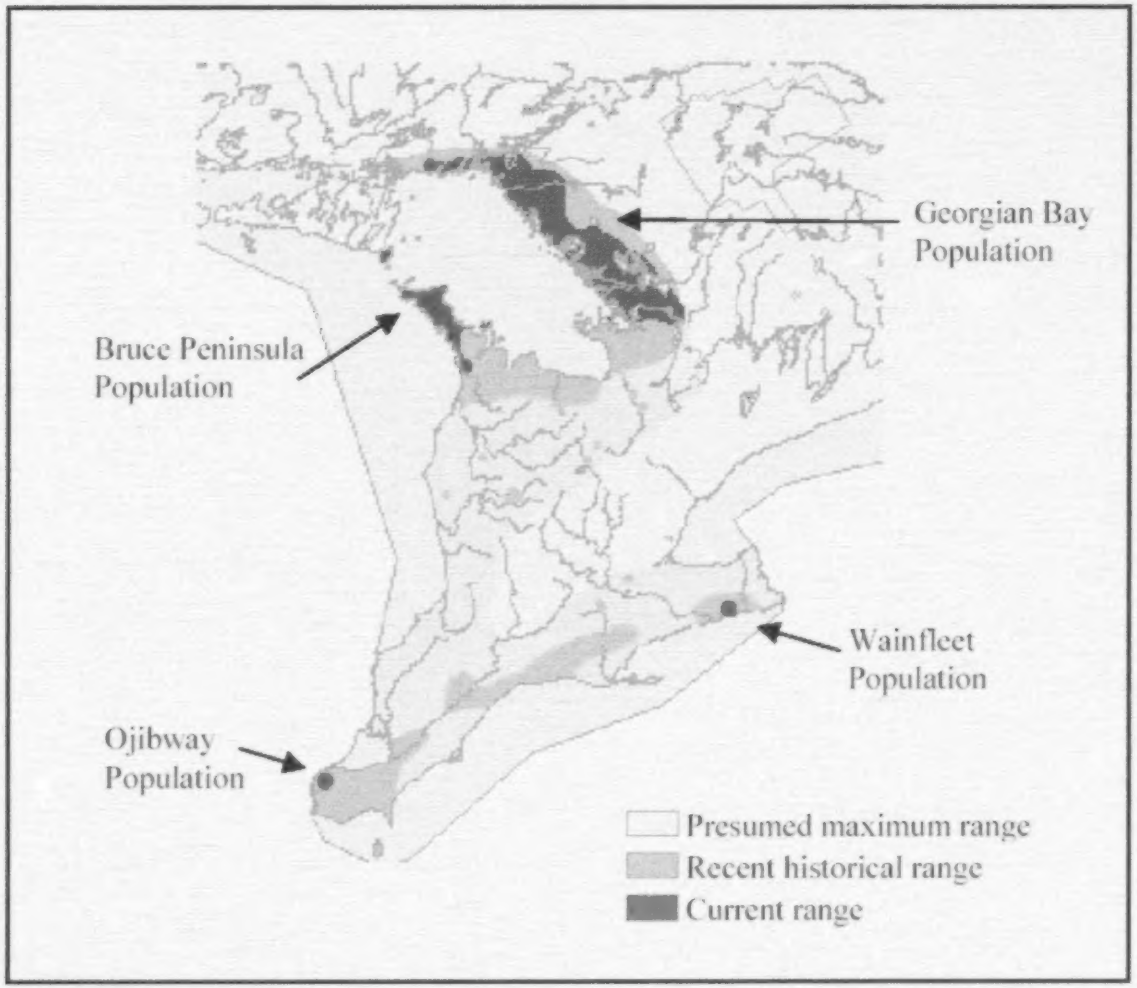

Figure 6. Former and current Ontario distributions for the Massasauga.

Potential, and ongoing, developments that threaten the integrity of local Massasauga populations in the Georgian Bay and Bruce Peninsula regions are too numerous to describe or document. Two notable examples, however, are the twinning and expansion of Hwy 69/400 along the eastern shoreline of Georgian Bay, and the West Bruce Lands project along the western shoreline of the Bruce Peninsula. When completed, both developments will negatively impact the quality of Massasauga habitat in their immediate vicinity, and data collected from areas cleared for the Hwy 69 corridor show that Massasaugas have also been negatively affected during the construction phase (Rouse *et al.* 2001). These examples are unique because members of the Massasauga recovery team have been given input into, or at least had the opportunity to comment on, construction and design of both developments. It is anticipated that large-scale developments like the previous examples will continue to be proposed, and thus in concert with smaller-scale cottage development, habitat quantity and quality will decrease within the Georgian Bay and Bruce Peninsula regions.

The Wainfleet and Ojibway populations also face continued loss of suitable habitat as one of the primary threats to their persistence (see Habitat Trends). As a larger area is formally protected at Wainfleet, and this population occurs in a more slowly developing rural area; it is reasonable to speculate that the Ojibway population is in greater jeopardy of extirpation. Massasaugas at the Ojibway site may also run a greater risk of being killed on the roadways, as the habitat fragments currently occupied are small, and some are decreasing in size (e.g., the Sandwich West Woodlot), whereas traffic volume increases. Massasaugas at Wainfleet are probably occasionally killed by agricultural machinery (Prior *et al.* 2000) as individuals have been observed spending substantial portions of their active seasons outside of the peatland habitat (Pratt *et al.* 2000).

SPECIAL SIGNIFICANCE OF THE SPECIES

As Ontario's only remaining venomous snake, the Massasauga occupies an important and unique "niche" in the province's fauna. Metaphorically, it symbolizes an important approach to wildlife conservation in the 21st century; that *Homo sapiens*, in this case Canadians, can co-exist with a creature that retains the ability to cause them harm. A healthy respect for an equally fascinating product of evolution is what is required, not a loathing of a potential threat to one's livelihood. In many Canadian's minds, rattlesnakes are creatures of the southern US deserts, not something to be found in cottage country. Consequently, there are many young Ontarions (the authors included) that have been thrilled to suddenly discover the existence of such an animal in "their own backyard". To be fair, there is also a significant percentage of Ontarions that would rather not have knowledge of such things—for them the message should be one of tolerance and co-existence. From a national conservation perspective, it is noteworthy that the most secure populations of *S. c. catenatus* in North America occur in the Georgian Bay and Bruce Peninsula regions of Ontario. Finally, Canada would be a poorer place, both in terms of biological and cultural diversity, were the Massasauga to be extirpated from its wetlands and prairies.

EVALUATION AND PROPOSED STATUS

Existing Protection or Other Status

Sistrurus catenatus catenatus is a "specially protected reptile" under Ontario's Fish and Wildlife Conservation Act (January 1999); making it illegal to harass, possess (without a permit), or kill the snake. The Eastern Massasauga was designated **Threatened** by COSEWIC in 1991 and by the OMNR in 1998. Using the Nature Conservancy's system, the Eastern Massasauga is ranked G3G4T3T4 (1996-10-31) globally (T denotes that the rank applies to a subspecies or variety) and S3 (1999-10-31) provincially (Ontario). The following are the status ranks for the states in which the Eastern Massasauga occurs: Illinois (S2), Indiana (S2), Iowa (S1), Michigan (S3S4), Minnesota (S1), Missouri (S1), New York (S1), Ohio (S?), Pennsylvania (S1S2), Wisconsin (S2). *Sistrurus catenatus catenatus* is a candidate for listing as endangered or threatened under the U.S. Endangered Species Act (USFWS 2002).

Assessment of Status and Authors' Recommendation

Since COSEWIC's 1991 assessment of the Eastern Massasauga's status in Canada, significant research and education initiatives have been conducted across the snake's Ontario range. The substantial increase in public awareness regarding the plight of this unique animal has undoubtedly decreased the number of Massasaugas wantonly killed. Also, the recent investigations at Wainfleet and Ojibway, and the protection of a portion of the bog habitat, are causes for optimism. However, habitat loss and fragmentation have occurred across the entirety of the Massasauga's Canadian range and road mortality is likely to continue increasing in areas traversed by roads. In all likelihood, these losses effectively negate the gains in survivorship made via education efforts. Assessed independently, the Wainfleet and Ojibway Massasauga populations certainly warrant Endangered status; however, given the isolated nature of the majority of existing snake populations in southern Ontario (e.g., *Elaphe obsoleta, Heterodon platirhinos*; each with COSEWIC status assessed across the entirety of their Canadian range), it would not be practical for COSEWIC to evaluate each of the Massasauga populations separately. Therefore, we recommend COSEWIC treat the four extant Massasauga populations as a whole, and consequently retain the taxon's **Threatened** status designation in Canada.

TECHNICAL SUMMARY

Sistrurus catenatus
Massasauga
Ojibway, Wainfleet populations, Georgian Bay, Bruce Peninsula populations
Occurrence in Canada: South and central Ontario

Extent and Area information	
• *extent of occurrence (EO)(km²)*	Georgian Bay – 5682 km^2 Bruce Peninsula – 1331 km^2 Wainfleet – 17.4 km^2 Ojibway – 12.8 km^2
• *specify trend (decline, stable, increasing, unknown)*	Unknown
• *are there extreme fluctuations in EO (> 1 order of magnitude)?*	No
• *area of occupancy (AO) (km²)*	Georgian Bay – 2852 km^2 Bruce Peninsula – 842 km^2 Wainfleet – 10.8 km^2 Ojibway – 8.7 km^2
• *specify trend (decline, stable, increasing, unknown)*	Declining
• *are there extreme fluctuations in AO (> 1 order magnitude)?*	No
• *number of extant locations*	4
• *specify trend in # locations (decline, stable, increasing, unknown)*	Declining
• *are there extreme fluctuations in # locations (>1 order of magnitude)?*	No
• *habitat trend: specify declining, stable, increasing or unknown trend in area, extent or quality of habitat*	Declining
Population information	
• *generation time (average age of parents in the population) (indicate years, months, days, etc.)*	6 years +
• *number of mature individuals (capable of reproduction) in the Canadian population (or, specify a range of plausible values)*	17,000-30,000
• *total population trend: specify declining, stable, increasing or unknown trend in number of mature individuals*	Declining
• *if decline, % decline over the last/next 10 years or 3 generations, whichever is greater (or specify if for shorter time period)*	----
• *are there extreme fluctuations in number of mature individuals (> 1 order of magnitude)?*	No
• *is the total population severely fragmented (most individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange, i.e., ≤ 1 successful migrant / year)?*	Yes in southern Ontario Probably in Central Ontario
• *list each population and the number of mature individuals in each*	Georgian Bay – 13,000-22,000 Bruce Peninsula – 4,000-8,000 Wainfleet – 40-70 Ojibway – 30-60
• *specify trend in number of populations (decline, stable, increasing, unknown)*	Decline
• *are there extreme fluctuations in number of populations (>1 order of magnitude)?*	No

Threats (actual or imminent threats to populations or habitats)	
– *decline in quantity and quality of habitat* – *increasing fragmentation of habitat* – *high and increasing mortality on roads* – *small numbers and isolated populations* – *slow rate of reproduction and delayed maturity* – *persecution by people*	
Rescue Effect (immigration from an outside source)	
• *does species exist elsewhere (in Canada or outside)?*	U.S.
• *status of the outside population(s)?*	Varied
• *is immigration known or possible?*	No
• *would immigrants be adapted to survive here?*	Unknown
• *is there sufficient habitat for immigrants here?*	No - South / Yes - Central
Quantitative Analysis	

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